

TABLE 2.—Free-air resultant winds (meters per second), based on pilot-balloon observations made near 7 a. m., (E. S. T.), during July, 1929

Altitude m. s. l.	Broken Arrow, Okla. (233 meters)		Burlington, Vt. (132 meters)		Cheyenne, Wyo. (1,808 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Havre, Mont. (762 meters)		Jacksonville, Fla. (65 meters)		Key West, Fla. (11 meters)		Los Angeles, Calif. (40 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
<i>Meters</i>	°		°		°		°		°		°		°		°		°		°	
Surface.....	S 5 E	1.9	S 15 W	2.0	N 87 W	2.1	S 10 E	0.1	S 63 W	0.7	S 4 E	1.6	N 22 E	0.1	S 45 W	0.6	S 60 E	2.1	N 64 W	0.9
500.....	S 27 W	6.3	S 51 W	4.0	S 87 W	2.2	S 89 W	2.2	S 46 W	1.1	S 18 W	7.6	S 38 W	1.8	S 38 W	1.8	S 90 E	5.4	N 80 E	0.7
1,000.....	S 42 W	8.5	N 84 W	4.7	N 75 W	2.3	N 75 W	2.3	S 70 W	3.0	S 12 W	7.3	N 61 W	1.0	S 28 W	1.7	S 55 E	5.3	N 87 E	0.9
1,500.....	S 43 W	4.7	N 81 W	6.6	N 74 W	1.8	N 85 W	4.0	S 70 W	3.0	S 2 E	5.4	N 66 W	3.0	S 20 W	0.8	S 60 E	4.1	S 85 W	1.2
2,000.....	S 54 W	2.0	N 83 W	8.0	S 75 W	3.9	N 63 W	2.3	N 81 W	4.2	21 E	3.9	N 73 W	4.1	S 13 E	1.2	S 54 E	3.8	S 75 W	2.9
2,500.....	S 70 W	1.0	N 70 W	8.6	S 83 W	4.0	N 60 W	2.7	N 70 W	5.3	S 56 E	2.7	N 88 W	6.2	S 13 E	1.3	S 41 E	2.4	S 54 W	3.0
3,000.....	S 46 W	0.8	N 76 W	9.8	N 88 W	2.9	N 60 W	2.7	N 60 W	8.2	S 77 E	2.3	S 77 W	8.2	S 7 E	0.9	S 17 E	1.6	S 23 W	3.6
4,000.....	S 25 E	1.0	N 71 W	10.4	N 74 W	2.9	N 63 W	3.5	N 71 W	10.0	S 75 E	2.9	S 71 W	12.0	S 8 E	1.5	S 10 E	1.4	S 11 W	4.9
5,000.....	N 80 E	1.0	S 56 W	2.9	N 78 W	2.2	N 69 W	10.4	N 61 E	2.3	S 79 W	14.7	S 41 E	0.8	S 55 E	0.2	S 5 W	2.1		

	Medford, Oreg. (446 meters)		Memphis, Tenn. (145 meters)		New Orleans, La. (25 meters)		Omaha, Nebr. (313 meters)		Royal Center, Ind. (225 meters)		Salt Lake City, Utah (1,280 meters)		San Francisco, Calif. (60 meters)		Sault Ste. Marie, Mich. (198 meters)		Seattle, Wash. (67 meters)		Washington, D. C. (34 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
<i>Meters</i>	°		°		°		°		°		°		°		°		°		°	
Surface.....	S 40 E	1.1	S 12 W	1.5	N 81 E	0.4	S 34 E	1.0	S 1 W	0.8	S 26 E	2.7	S 70 W	1.0	Calms		S 56 E	0.8	N 54 W	0.3
500.....	S 36 E	0.9	S 47 W	4.5	S 18 W	1.5	S 12 W	3.9	S 52 W	3.4	N 83 W	2.7	N 83 W	2.7	S 87 W	3.3	N 33 E	0.6	N 51 W	3.8
1,000.....	S 32 W	0.8	S 57 W	3.9	S 13 E	2.3	S 36 W	5.7	S 86 W	4.8	N 47 W	5.7	N 81 W	6.6	N 81 W	6.6	N 48 W	1.4	N 47 W	3.5
1,500.....	N 55 E	0.4	S 71 W	2.9	S 22 E	2.3	S 58 W	4.1	N 85 W	5.8	N 48 W	3.0	N 72 W	7.0	N 72 W	7.0	N 77 W	0.7	N 63 W	4.6
2,000.....	S 11 W	0.8	S 59 W	2.1	S 26 E	2.0	S 74 W	3.3	N 85 W	6.1	S 13 E	4.0	N 56 W	1.6	N 69 W	7.3	S 62 W	2.7	N 69 W	4.9
2,500.....	S 39 W	5.4	S 77 W	2.2	S 44 E	2.2	S 85 W	4.2	N 79 W	5.6	S 11 W	2.8	S 81 W	3.3	N 67 W	9.2	S 53 W	3.6	N 81 W	5.4
3,000.....	S 39 W	7.8	N 88 W	2.1	S 67 E	1.9	N 88 W	5.4	N 69 W	5.8	S 36 W	1.7	S 80 W	5.1	N 63 W	10.2	S 61 W	4.2	N 69 W	7.1
4,000.....	S 49 W	9.3	N 71 W	1.4	N 69 E	2.0	N 69 W	7.3	N 55 W	6.5	S 60 W	2.8	N 66 W	11.0	N 66 W	11.0	S 71 W	7.3	N 73 W	6.8
5,000.....			N 51 W	2.3	N 16 E	1.2	N 77 W	8.0	N 44 W	6.0			N 68 W	10.8					N 51 W	5.6

TABLE 3.—Observations by means of kites, captive and limited-height sounding balloons, and airplanes during July, 1929

	Broken Arrow, Okla.	Due West, S. C.	Ellen- dale, N. Dak.	Groes- beck, Tex.	Royal Center, Ind.	Naval Air Station, D. C.
Mean altitudes (meters), m. s. l., reached during month.....	2,339	2,387	2,871	2,085	2,670	3,365
Maximum altitude (meters), m. s. l., reached and date.....	3,879	4,612	4,707	3,586	4,475	5,221
Number of flights made.....	28	16	31	24	22	21
Number of days on which flights were made.....	28	15	25	24	22	20

1 29th. 2 25th. 3 8th. 4 18th. 5 12th.

In addition to the above there are approximately 100 pilot balloon observations made daily at 45 Weather Bureau stations in the United States.

551.506 (73)

WEATHER IN THE UNITED STATES

THE WEATHER ELEMENTS

By P. C. DAY

GENERAL CONDITIONS

July was notable chiefly for the variable conditions existing during the several parts of the month, though none of these were so pronounced as to make it unusual to any important extent. Tornadoes were notably few and unimportant and no tropical hurricanes occurred.

PRESSURE AND WINDS

Barometric pressure during July, 1929, exhibited about the usual conditions as to distribution, being high over the southeastern district and along the coast of the far Northwest.

The departures from normal were not pronounced, but the monthly means were above normal over practically all sections of the country, except for small areas in the Middle Plateau region and locally in North Dakota and

near-by States, where there were a few negative departures.

The changes from the preceding month were also small, being above the June values in practically all sections save at a few points in or near the Middle Plateau where they were slightly less than those for June.

No important barometric depressions appeared on the daily weather maps and only one cyclonic storm was traced for any considerable distance. Depressions causing important precipitation occurred during the 1st and 2d, when beneficial rains occurred in the middle Mississippi and Ohio Valleys and thence northeastward to the Atlantic coast, heavy rains occurring over local areas in that general region, which, during the 3d extended southward into portions of the Gulf States. On the 4th and 5th precipitation was rather general from the upper Mississippi Valley northeastward over the Lake region to New England, and on the 6th a new depression developed in the middle Missouri Valley and general rains occurred over a narrow area from the middle Rocky Mountains eastward to the Atlantic and northeastward

over New England. By the 7th this depression was centered over northern Michigan and rains had extended into that region and continued in the Ohio Valley and near-by areas, the falls being heavy locally. By the following morning the depression had largely dissipated, but another had formed in the upper Mississippi Valley and generally light rains had fallen over that and some near-by areas. This depression moved during the following 24 hours to northward of Lake Superior, causing more or less scattered thunderstorms in the upper Lake region and southward over portions of the upper Mississippi and Ohio Valleys and some heavy showers were reported from points in the South Atlantic and East Gulf States. During the first half of the second decade local showers prevailed over widely scattered areas to eastward of the Great Plains. During the latter part of this decade showers continued locally, but they generally covered less extensive areas and the falls became lighter as a rule, though about the 19th there was considerable rain from the Ohio Valley and lower Lake region eastward to the Atlantic coast, and in Florida and other parts of the Gulf States, and they continued at the end of the decade locally along the entire Atlantic coast.

At the beginning of the last decade low-pressure existed off the Carolina coast and heavy rains occurred in the early morning of the 21st at Hatteras, a total of nearly 8 inches occurring within 24 hours. This rainstorm was extremely local, only small amounts being reported from near-by points. During the remainder of the third decade precipitation was largely local, some heavy rains occurring generally over the Gulf States on the 24th and 25th, Galveston reporting over 5 inches on the morning of the 25th, and some beneficial rains fell in the upper Mississippi Valley and thence eastward to New England on that and the following day. For the remainder of the month such precipitation as occurred was confined to scattered local rains, mostly in the eastern districts, being of benefit only in a few instances.

The wind and other damaging storms were of the character usual to the midsummer season and usually affected small areas and were not of severe form. A few minor tornadoes occurred and damaging hail was reported on a number of dates. All told, however, damaging storms were less frequent than during June, but they occurred in practically all parts of the month.

The details of such local storms as were reported appear in the table at the end of this section.

TEMPERATURE

July had varying temperature conditions, though no records of importance were broken. The first 10 days were abnormally warm in most western districts, particularly in the Southwest, some of the warmest days of the month being experienced during that period in Arizona, Utah, and other near-by States. In other portions the average temperatures were not far from normal generally, though during the latter part of the decade high temperatures prevailed in many eastern sections.

The first part of the second decade had mostly moderate temperatures, though warm in the middle Plains and to the northwestward. The week from the 16th to 23d was generally cool over the eastern part, the negative departures ranging up to 6° or more in the more eastern portion, some of the lowest temperatures of record in July being reported from some southeast coast districts. The week also averaged cooler than normal in the far Northwest, though not so much below normal as in the more eastern portions. From the middle Plains to the

eastern portion of the Plateau States and over the Southwest the average temperatures for this period were considerably above the normal, especially in the more northern districts, where the weekly averages ranged up to 6° or more above the normal and the maximum temperatures were frequently above 100°.

The final eight days were warm throughout all northern and central districts, save at a few points in the far west, the warmest days of the month coming during this period, especially during the last few days, when the maximum readings were above the 100° mark at many points. Over all southern districts from central Arizona eastward this period was generally cooler than normal.

The monthly mean temperatures, as a rule, did not depart greatly from normal conditions, the month being warmer than normal over the greater part of the country, though it was slightly cooler than normal over a considerable area from the Gulf coast northeastward to the Ohio Valley and New England, save that along the immediate eastern coast from Chesapeake Bay northeastward the mean temperatures were generally slightly above the normal. The warmest areas in comparison with the normal were the upper Missouri Valley, the Dakotas, and the Middle and Northern Plateau States, where the monthly means ranged from 2° to 4° daily above the normal.

Maximum temperatures of 100° or somewhat higher occurred at some time during the month over the greater part of the country, the highest reported being 123° at a point in southeastern California, and a record of 120° was made in Arizona, while values from 105° to 112° occurred at many points in the west. These high marks were reported on a number of dates, but mostly near the end.

Minimum temperature records for July were broken in a few instances, notably over the Southeastern States about the 19th to 21st, but otherwise the temperatures were not unusually low. Over most districts changes to lower temperatures at night were sufficiently frequent to afford relief from the high day temperatures that prevailed in some districts for considerable periods, and the month as a whole was a fairly pleasant one.

PRECIPITATION

There was a general lack of sufficient precipitation for the best crop growth over many portions of the country, though some sections received about the usual amounts and in a few instances unusually large amounts were received. In general the amounts were above normal from Ohio southwestward to Arizona and Utah and in Texas and Florida. Over the areas east of the Rocky Mountains even where the precipitation was in excess, it was poorly distributed during the various parts of the month, the major portions occurring during the early part, so that at the end there was a very general and urgent need for more precipitation over large areas.

Important deficiencies in precipitation were experienced in much of the Atlantic coast areas from Virginia northward and over much of the spring-wheat area, and there was a considerable area in the middle Gulf States with deficient precipitation. On the other hand, small areas in the Southwest had unusually large amounts compared with the normal and there were important sections in the middle Mississippi Valley that had amounts in excess of the normal.

Precipitation was generally less than normal over the entire Pacific coast.

In a few instances the monthly precipitation was either the least of record for July or closely approached that quantity. Despite these deficiencies, unusually large amounts were received in a few localities, particularly in the Southwest.

RELATIVE HUMIDITY

The droughty condition, as shown by the deficiency in precipitation, was reflected in the relative humidity,

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SEVERE LOCAL STORMS, JULY, 1929

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path, yards ¹	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Clinton County, Iowa	1	3 p. m.			\$4,000	Wind	Details not reported	Official, U. S. Weather Bureau
Nashville, Tenn.	1	6-7 p. m.				Thunderstorm and wind	Considerable damage to property in central and western sections of the city.	Do.
Greencastle, Ind., and vicinity.	1					Wind	Roofs blown off; several barns removed from foundations; corn and hay crops injured. Storm began late June 30.	Do.
Rush and Barton Counties, Kans.	1	P. m.	2,640		75,000	Heavy hail	Damage chiefly to wheat over path 12 miles long.	Do.
Anniston, Ala.	2					Thunderstorm	Trees and windows broken; traffic delayed.	Do.
Plainview, Tex., (near)	2					Hail	Crops damaged.	Do.
Dalton, Nebr., (near)	3	3 p. m.	1,320		15,000	do.	Considerable injury to crops in places. Path 7 miles.	Do.
Carroll County, Iowa	3	6:30 p. m.			100,000	Wind and flood	Damage to property by wind and water equally divided.	Do.
Huron County, Ohio	4	9:30 p. m.	66			Tornadic wind	Damage confined largely to trees over path 1/4 mile long.	Do.
Lincoln, Nebr.	5	2:15-2:30 a. m.	1,760		100,000	Hail and flood	Much damage to buildings; shrubbery stripped; gardens ruined; auto tops punctured. Path 2 miles long.	Do.
Louisa and Henry Counties, Iowa	5	6 p. m.			4,500	Wind	Character of damage not reported	Do.
Springfield, Ill.	5					Tornadic wind	Roofs, trees, garages, and chimneys damaged	Do.
Liberty County, Mont.	6		4-5 mi.			Hail	Crops damaged 10 per cent to total.	Do.
Rotan, Tex.	6		3 mi.			do.	1,500 acres of cotton destroyed.	Do.
Ness, Gray, Meade, Ford, Hodgeman, Haskell, and Finney Counties, Kans.	7	2:30-6 p. m.			328,000	Heavy hail	Much damage to wheat, also minor damage to farm property.	Do.
Mount Vernon, S. Dak. (near)	7	4 p. m.	5 mi.		75,000	Hail and wind	Crops destroyed; poultry killed; farm buildings damaged.	Do.
Farwell, Nebr.	7	4:40 p. m.	3 mi.		10,000	Hail	Considerable loss of crops ready to harvest. Path 6 miles.	Do.
Osceola, S. Dak.	7	5 p. m.	75		5,000	Tornado	Farm buildings wrecked.	Do.
Lincoln and Dawson Counties, Nebr.	7	5:30-6 p. m.	1-3 mi.		10,000	Hail	Total loss of small grain in places. Path 25 miles.	Do.
Wentworth, S. Dak. (near)	7	7 p. m.	2 mi.		50,000	do.	Crops destroyed.	Do.
Goodwell, Okla.	7	7:30 p. m.	1,760		51,000	do.	Extensive damage to crops; other minor injury. Path 7 miles.	Do.
Lamesa, Tex.	7	11 p. m.	2 mi.			do.	10,000 acres of cotton destroyed.	Do.
Cimarron, N. Mex.	8	2 p. m.	2 mi.		10,000	do.	Gardens, orchards, and roofs damaged.	Do.
Wood and Portage Counties, Wis.	8	4 p. m.		3	5,500	Wind, rain, and electrical.	3 men and 8 horses killed by lightning; some property damage by wind.	Do.
Davenport, Iowa and vicinity.	8					Wind and rain	Telephone and power lines broken; traffic impeded; minor injury to crops.	Daily Times (Davenport, Iowa).
Greenville, S. C. (near)	10	3 p. m.			1,500	Thunderstorm	A barn and contents destroyed.	Official, U. S. Weather Bureau
Leola, S. Dak.	10	6 p. m.			10,000	Hail and wind	Crops ruined; buildings damaged or wrecked.	Do.
Berryville, Va., and vicinity.	10		1,320			Heavy hail	Farm crops destroyed over path 2 miles long.	Do.
Reno County, Kans.	11	1:30 a. m.			25,000	Tornado	Damage chiefly in Hutchinson. Much uncut wheat ruined; soda ash plant damaged.	Do.
Saltillo, Tex. (near)	11	4 p. m.				do.	Considerable injury to crops over small area; 1 barn damaged.	Do.
Gurley, Nebr. (near)	11	5:30 p. m.				do.	Practically no damage.	Do.
Thomas County, Kans.	11	10:30 p. m.			1,500	Small tornado	Buildings on 1 farm damaged.	Do.
Devils Lake, N. Dak., and vicinity.	11					Wind, rain, electrical and a tornado.	Many farm buildings wrecked; much damage by tornado at Grand Harbor and Crary.	Do.
El Paso, Tex.	11		1,760		25,000	Cloud-burst	Streets, many residences, and stores damaged by water.	Do.
Mellette, S. Dak. (near)	12	6 p. m.	8 mi.		90,000	Hail and wind	Crops devastated; some damage to buildings.	Do.
Ludington to Muskegon, Mich.	13	A. m.			40,000	Wind and thunderstorm.	Considerable damage by lightning and water; oil barge and contents destroyed.	Do.
Winneshiek County, Iowa	13	4 a. m.				Wind	Heavy crop damage.	Do.
Calhoun Falls, S. C.	13	8-8:40 p. m.			5,000	Wind squall	Property and timber damaged.	Do.
Wayne, Taylor, Tama, Page, Montgomery, Marion, Louisa, Fremont, Dallas, and Adams Counties, Iowa.	14	P. m.			115,000	Wind and floods	Severe crop and property damage.	Do.
Queen Anne County, Md.	14					Electrical	A granary, with contents, and a barn and farm implements burned; livestock killed.	Do.
Windsor, Colo.	15	3:30 p. m.	1,760			Hail	Grain about one-third damaged.	Do.
Memphis, Tenn.	16-17				25,000	Thunderstorm	Many basements and other low places flooded streets damaged.	Do.
Natoma, Kans.	17	7:30 p. m.	4 mi.		2,000	Heavy hail	Some injury to buildings and crops.	Do.
Anniston, Ala.	17			1		Thunderstorm	Stores flooded; traffic impeded.	Do.
Greenville, S. Dak.	17	P. m.	3 mi.		5,000	Wind	Buildings damaged.	Do.
Trumansburg, N. Y.	18	2-3 p. m.	5 mi.		5,000	Hail	Crops injured.	Do.
Artesia, N. Mex.	18	2:30 p. m.	10 mi.			Hail and wind	Crops cut; orchards injured; small buildings blown over.	Do.

¹ Mi. signifies miles instead of yards.